DUAL-COMB SPECTROSCOPY USING QUANTUM AND INTERBAND CASCADE LASERS[a]

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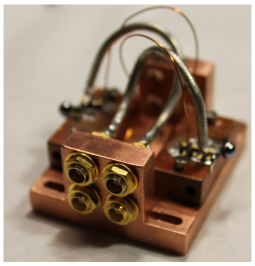

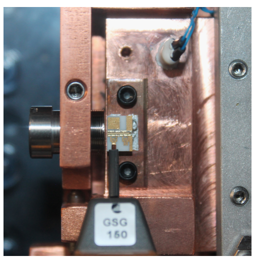

Dual-comb spectroscopy (DCS) using quantum cascade laser (QCL) or interband cascade laser (ICL) frequency combs presents an opportunity for miniaturized and fully electronically controlled broadband spectrometers with no moving-parts and all-electrical control that can serve as alternatives to systems based on broadly tunable lasers or external cavity lasers. In contrast to systems based on conventional tunable laser sources, a DCS system gives instantaneous access to the optical information across the entire spectral bandwidth through a multi-parallel heterodyning process, which enables acquisition times in the μs-range. The main drawback of quantum and interband cascade laser frequency combs is the excess phase noise observed, which affects the averaging capabilities of the DCS systems. In principle, coherent averaging can be implemented using active feedback control, but this adds additional complexity to the systems, which negates the intrinsic advantage of the monolithic comb emitters. Here, we report on DCS using free-running lasers, where a coherent averaging algorithm is implemented to correct for phase noise via purely computational means. The correction algorithm leverages the temporal mode coherence masked by the noise and is generally applicable to all DCS systems affected by excessive phase noise. Spectroscopic detection of molecular species with broadband spectral signatures in the mid-infrared will be discussed. Further details on the spectroscopic systems, as well as a discussion of current limitations and future directions of this DCS technique will be given.

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